REDACTED – FOR PUBLIC INSPECTION

Attachment A

ANALYSIS OF FIBER DEPLOYMENT ECONOMICS FOR EFFICIENT PROVISION OF COMPETITIVE SERVICE TO BUSINESS LOCATIONS

White Paper #1

REDACTED – FOR PUBLIC INSPECTION

TABLE OF CONTENTS

SUMMARY

This communications network cost analysis was prepared by CostQuest Associates for Windstream Services, LLC, to assess efficient competitive local exchange carrier (CLEC) costs of building out fiber facilities and associated IP electronics to serve business customers with Ethernet services.

This white paper consists of two parts. The first section updates a prior AT&T examination of CLEC network economics to estimate the construction costs for IP-based fiber networks to serve business customers.[1] In the second section, the costs for this build approach are compared to the revenue needed to justify the network build (a "revenue hurdle" analysis) as well as to monthly costs to lease last-mile access (a "build-versus-buy" analysis). These two analyses (revenue hurdle and build-versus-buy) together provide a framework for considering when a CLEC might find that the most economically rational decision is to build last-mile network facilities, lease these network facilities, or avoid offering service to a customer. The white paper also includes an examination of the extent to which market share and density affect per-unit costs of the infrastructure.

The AT&T cost study referenced in this analysis examined break-even points at which it becomes economically feasible for a CLEC to build out fiber facilities to serve business customers with DS1 or DS3 services. To perform its modern-day assessment, CostQuest used study assumptions from the AT&T analysis (e.g., length of fiber ring, number of customers on the ring, average length of lateral from the ring to the customer location) and, wherever possible, modern-day technologies and inputs that are publicly available. Effectively, this method of analysis provides a mechanism to compare changes in cost over time for typical services that CLECs provide to business customers on contemporary networks. To enable maximal public disclosure, review, and discussion, this analysis uses public inputs and assumptions whenever possible. The goal is to provide an analysis reflective of an efficient hypothetical provider, not a particular provider, under average cost conditions.

Chief findings of this analysis are as follows:

- A CLEC faces a high hurdle for overbuilding because its costs to install new last-mile network facilities (fiber ring, laterals, and electronics) and establish new building entries remain significant. Costs of placing plant on poles, buried underground, or within conduit systems and attaining entry to end user buildings—while subject to variation based on where the network is deployed and the technologies installed—still necessitate a significant capital outlay. Moreover, because the CLEC is at best the second entrant, its likely number of revenue-generating

---

[1] *See* Attachment B to Letter from Joan Marsh, Director, Federal Government Affairs, AT&T, to Marlene Dortch, Secretary, FCC, CC Docket Nos. 01-338, 96-98, 98-147 (filed Nov. 25, 2002) ("AT&T Study Letter"). The study was cited in the Commission's *Triennial Review Order*. *See, e.g.*, *Review of the Section 251 Unbundling Obligations of Incumbent Local Exchange Carriers,* Report and Order and Order on Remand and Further Notice of Proposed Rulemaking, FCC 03-36, 18 FCC Rcd. 16,978, 17,156 ¶ 298 n.859 (2003) ("*TRO*") (citing the AT&T study when finding "for DS1 loops and some DS3 loops, overbuilding to enterprise customers that require services over these facilities generally does not present sufficient opportunity for competitors to recover their costs and, therefore, may not be economically feasible").

customer locations over which to amortize ring costs is diminished, which raises the CLEC's average costs per revenue-generating customer location served from the ring.

- The costs of building new last-mile network facilities as compared with the revenue that can be generated from those facilities (i.e., the revenue hurdle) shows that a CLEC can build out its own last-mile facilities only if it can attain substantial end user density and penetration: For a 30-mile fiber ring with 20 revenue-producing commercial buildings on the ring (the scenario presumed by AT&T), CLEC self-deployment of last-mile facilities to serve a single customer in each building would not be economically viable—based on current services, retail rates, and costs—unless each customer purchases more than 1 Gbps of capacity (or lesser amounts reaching the same amount of average revenue per location).[2] To break even when providing lower bandwidth services to a location, a CLEC needs the building to contain multiple customers who subscribe to its service: For example, in lieu of a single 1 Gbps capacity customer, a CLEC must have at least three 50 Mbps customers or at least seven 10 Mbps customers in the building to generate equivalent revenue and thus make deployment feasible.[3]
- With respect to a build-versus-buy analysis, when average wholesale published rates are considered under the same cost assumptions, it appears to be more economical for a CLEC to build out new facilities, versus leasing wholesale Ethernet service only when more than 110 Mbps of capacity is required by the customer(s) in a building. This number increases when discounted wholesale rates are considered. However, a build-versus-buy analysis does not take into account retail marketplace conditions that will affect the ultimate viability of providing competitive service. Some data suggest that retail Ethernet rates may be lower than wholesale rates for some service speeds; in such cases, leasing will not be a viable alternative to deploying facilities because the CLEC could not expect to recover its lease expense. Additional data collection and analysis—reflecting rates experienced on both the wholesale and retail "sides"—should be undertaken to elucidate this potential concern.
- Current wholesale Ethernet rates, even if less than retail rates, may not have a meaningful impact on a CLEC's decision to deploy its own-last mile facilities. In particular, the analysis suggests that an economically rational CLEC will not self-deploy to serve a single customer with less than 1 Gbps of capacity per building even if building offers a more attractive option than wholesale lease payments. This is because the revenue hurdle is higher than the cross-over point in the build-versus-buy analysis.
- Finally, increased market penetration dramatically reduces the average per-building cost of constructing network facilities, holding density levels constant, and thus lowers the revenue hurdle needed to justify constructing facilities. Thus, the early entrant, in most cases the

---

[2] Throughout this paper when a service capacity or speed is described, that capacity is symmetrical with respect to the upstream and downstream channels.

[3] Revenue from multiple lower-speed circuits sold to customers in a single building, aggregating to less than 1 Gbps, may exceed the cost of deployment because market prices per Mbps are higher for lower capacity circuits.

incumbent local exchange carrier (ILEC), that has achieved significant market share currently possesses a significant unit cost advantage over later entrants.

SECTION ONE—METHODOLOGY

This analysis models a Metro Ethernet (MetroE) IP architecture. The designed network, like AT&T's prior study of last-mile costs, consists of a 30-mile fiber ring with 20 connected buildings.[4] Adopting the same network design assumptions for this analysis as AT&T's enables a consistent baseline for considering changes to network deployment costs.

Based on the modeled network, two different comparative analyses were performed. The first is a revenue hurdle analysis that compares the cost of network construction (converted to recurring capital and operating costs) to the retail market price for Ethernet service (i.e., the revenues that could be generated from the use of the constructed facility to provide Ethernet).[5] The second is a build-versus-buy analysis that compares the cost of network construction to the cost of purchasing wholesale access services (assuming no special construction charges are imposed).

THE MODELED NETWORK

The modeled network is based largely on the design previously used by AT&T when performing a similar break-even analysis.[6] Some of the assumptions, however, were modified to incorporate today's CLEC practices (based on Windstream input) and current technologies and costs. Wherever possible, current technology and cost assumptions were derived from the Connect America Cost Model (CAM).[7]

The intent of this cost modeling exercise is to reflect costs of an efficient carrier when facing network build-out using reasonable cost assumptions. Network construction costs, however, can vary by location based on where the network is constructed and the network technologies being installed.[8]

While the original AT&T study included both loop and transport costs and revenues, this analysis focuses only on the last-mile costs from the customer location to the local service office (LSO) (i.e., the loop) and

---

[4] *See* AT&T Study Letter, Attach. B at 5.

[5] The source of retail DIA Ethernet prices was Telogical Systems (Telogical) obtained April 20, 2015.

[6] *See* AT&T Study Letter, Attach. B at 2.

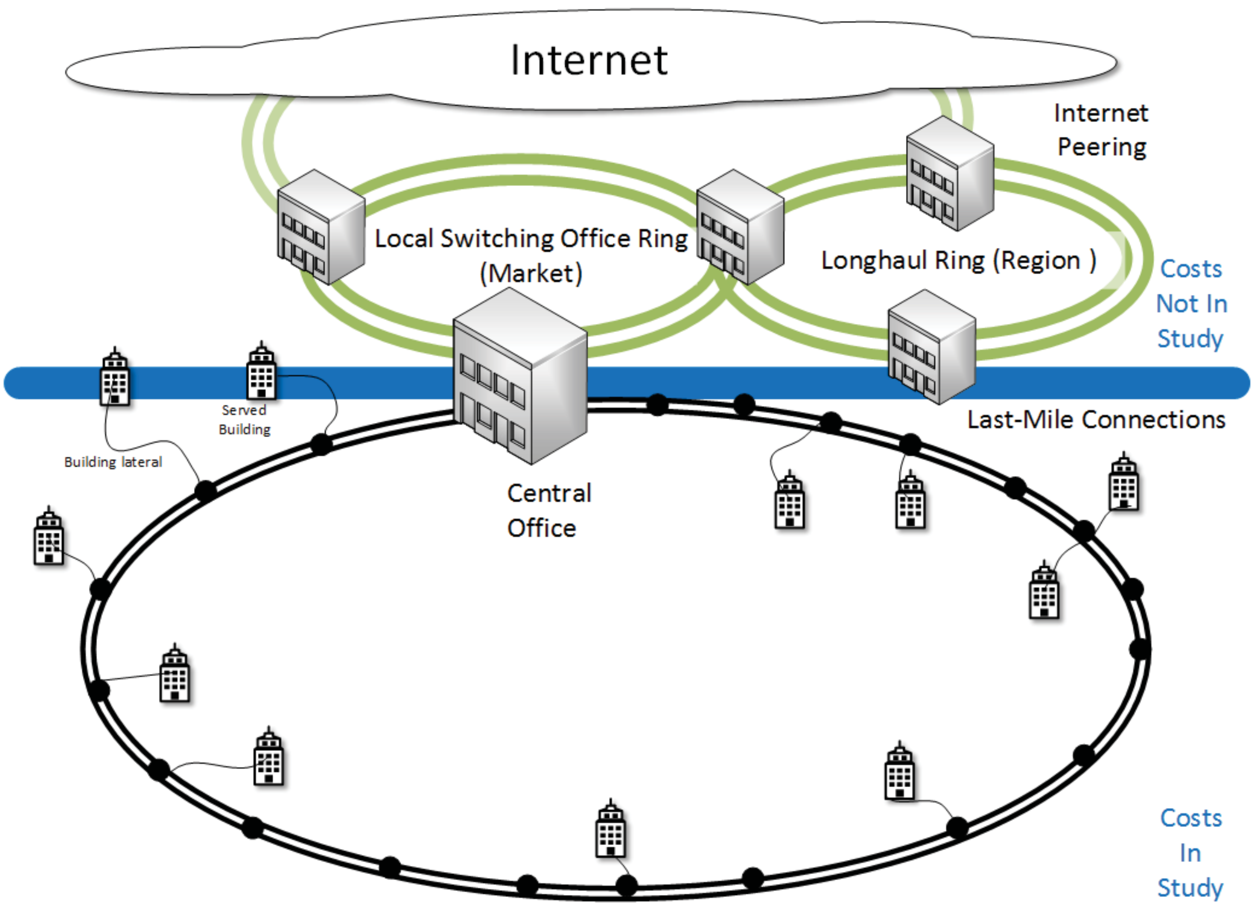
[7] Outside plant values were sourced from the adopted CAM Capex inputs (v21). *See Price Cap Carrier Resources*, FCC (updated May 21, 2015), https://www.fcc.gov/encyclopedia/price-cap-resources (follow "Connect America Cost Model v4.1.1 Default Inputs" hyperlink) ("CAM Capex inputs").

[8] Specifically, installing resilient high-capacity networks to business customers in urban and suburban areas may incur some of the highest network construction costs per mile versus comparable construction in residential and/or rural areas. This is because costs for underground excavation, protected conduit systems, and building access are more likely to be incurred in urban and suburban areas. At the same time, however, a carrier's *per-location* costs in more densely populated areas will be lower than in rural areas if the carrier's market penetration level is sufficient to realize economies of scale.

excludes revenue and costs associated with the transport beyond the LSO.[9] As such, costs to move data from LSO to LSO and costs to move data across markets are not included.

The figure below provides an illustration of the modeled network.

Figure 1—**The modeled network**



Major assumptions in this analysis that were based on the AT&T study include the following:

- The network consists of a 30-mile fiber building ring connecting customer buildings.
- Each building is provided two fiber strands on the ring. [10]

9 The transport portion of the network was excluded to focus only on the cost of building the network from the LSO to the location of potential customer demand. It is reasonable to assume that if a CLEC decides to enter an area with its own facilities, it likely already has proven a viable economic case for collocation at the LSO.

10 Add-drop equipment is not used to share facilities due to the complexities of adding new customers at different times and/or maintaining equipment at a site where there is no longer a customer.

- Each building is served via a 500-foot, 12-strand fiber lateral from the ring.
- The building ring serves 20 buildings.
- Electronics are placed in each building and at the LSO.
- A rental fee to cover collocation and power is assumed for each served building.[11]
- The density weight applied to material and labor is 0% Rural, 85% Suburban, and 15% Urban.

Major assumptions that *differ* from the AT&T study are the following:

- A 48-strand fiber in the original analysis was upgraded to a 288-strand cable, consistent with current Windstream practice.[12]
- The 100 percent underground construction assumption in the AT&T study was replaced with a mix of aerial, buried, and underground plant, which was derived from the national average CAM Plant Mix table.
- CAM public inputs were used for current material and labor prices for cable and structure.[13]
- All pole attachments are assumed to be on leased poles.
- Consistent with Windstream experience, the analysis assumes 95 percent of the time the CLEC will be required to build its own conduit structure for underground fiber placements.
- Electronics costs to host at the LSO and terminate at the customer premise are based upon the latest Windstream pricing sources.[14]
- As noted above, transport costs were not considered.
- Each collocation site on the LSO rings was modeled to contain packet optical routers that provide transport to the CLEC POP. Each Ethernet ring terminates on an Ethernet card in the same router, and the Ethernet customer terminal is available in 1GE and 10GE capacity. These assumptions are based on Windstream's modern-day practices.

MODELED COST ANALYSIS

Based on the assumptions noted above, the following provides a summary of the capital investments for building out a 30-mile loop ring, twenty 500-foot laterals to reach each of the buildings served by the ring, and IP electronics in the Central Office/LSO at each customer building.

---

11 This monthly fee of $678 was employed in the prior AT&T study. Recent Windstream data yield a similar, if not a slightly higher, value, so the AT&T input was retained.

12 This change in assumption achieves a 500 percent increase in additional capacity for approximately 15 percent additional outside plant investment. Upgrading the cable in this manner only requires a 10 percent increase in total network investment.

13 Input workbooks are available for download at http://www.fcc.gov/bureaus/wcb/Connect_America_Cost_Model_v4.1.1Default%20Inputs.zip. The CAM Capex inputs provided labor, material, and structure values. Capital Cost (Annual Cost factors) and Operating Expense factors also were taken from the adopted CAM (ACF8 50 V6 and Opex V8). *See* CAM Capex inputs.

14 Appropriate inputs were not available in the adopted CAM inputs.

Table 1—**Network component investments** (values in parentheses indicate quantity)

Network Component	Capital Investment
Building Ring	$ 2,082,446
Building Lateral (20 buildings)	$ 80,281
Premise if 1 Gbps Electronics (20 buildings)	$ [redacted]
Premise if 10 Gbps Electronics (20 buildings)	$ [redacted]
CO Electronics – Ethernet	$ [redacted]
Total: if up to 1 Gbps Ethernet in each Building	$ 2,327,257
Total: if 1 Gbps to 10 Gbps Ethernet in each Building	$ 2,591,256
Per Building: Ethernet, if up to 1 Gbps	$ 116,362
Per Building: Ethernet, if 1 Gbps to 10 Gbps	$ 129,563

These capital investments produce the following monthly costs for the ring and twenty laterals using the CAM annual charge factors (ACFs) and CAM operating expense factors:[15]

Table 2—**Monthly costs** (values in parentheses indicate quantity)

Network Component	Monthly Cost
Building Ring	$ 35,764
Building Lateral (20 buildings)	$ 1,402

15 Monthly costs consist of depreciation, cost of money, taxes, and operational costs, and development of these costs is consistent with the CAM methodology. A sensitivity not explored in this paper is the impact of the useful lives of the assets placed in construction. Adopting CAM inputs implies the useful lives of some assets can be decades, but this is not necessarily consistent with the contract renewal cycle of a CLEC. In its original analysis, AT&T voiced concerns about this assumption. *See* AT&T Study Letter, Attach. B at 4, n.6 ("If the lateral life is assumed to be the same as that of an underground fiber, the overall cost declines. . . . However, such a long life is unreasonably conservative given the volatile nature of demand from a single customer location (customer contracts typically run only 2 to 3 years).").

Building Rent (20 Buildings @ 678/month/building)	$ 13,560
Premise if 1 Gbps Electronics (20)	$ [redacted][16]
Premise if 10 Gbps Electronics (20)	$ [redacted]
CO Electronics – Ethernet	$ [redacted]
Total: If up to 1 Gbps Ethernet for each Building	$ 54,238
Total: If 1 Gbps to 10 Gbps Ethernet for each Building	$ 59,874
Per Building cost of ring and lateral: Ethernet, up to 1 Gbps	$ 2,712
Per Building cost of ring and lateral: Ethernet, 1 Gbps to 10 Gbps	$ 2,994

Section Two—Break-Even Analyses

Using the monthly costs displayed above, two economic views of break-even cost analyses for the local network facilities (fiber ring, laterals, and electronics) were developed.[17] The first is a revenue hurdle analysis. The second is a build-versus-buy analysis.

[16] The 1 Gbps Electronics cost was used for all services less than 1 Gbps. At larger capacities, 1-10 Gbps Electronics costs were used.

[17] The costs considered in the breakeven analyses are economic costs, including the cost of the capital used (including depreciation, cost of money, and income taxes related to the cost of money). The contribution analysis identifies the difference between revenues and economic costs at a product level. Financial profit is determined at the firm level, includes the cost of debt but not equity, and includes shared and common costs not attributable to an individual product.

REVENUE HURDLE ANALYSIS

The revenue hurdle view considers the amount of revenue needed to offset the costs of deploying new last-mile facilities.[18] The retail revenue amounts and corresponding service levels are based upon a Telogical survey of retail Ethernet pricing.[19]

Employing the study assumptions described above, revenue generated from the construction of the fiber ring and laterals must exceed $2,712 per month on average for each building for the CLEC to break even. To serve a single customer per location, that implies that the CLEC would need each customer to purchase more than 1 Gbps of capacity. At 1 Gbps, building out the Ethernet connection would yield a negative contribution for the CLEC, i.e., the monthly recurring Ethernet retail revenue would not offset the per-building monthly cost:

	Monthly Recurring Charge per circuit	$2,157
-	Per-building monthly cost[20]	$2,712
	Contribution	($555)

Alternatively, using the Telogical retail price data, Figure 2 shows that the break-even (i.e., hurdle) point for the CLEC to deploy its own facilities along a 30-mile ring with 20 connected buildings can also be achieved when multiple lower capacity circuits are sold at each location. Because the market prices per Mbps are higher for lower-capacity circuits, there is not a one-to-one correlation between reduced bandwidth levels of the purchased circuits and the increased number of circuits that would need to be sold. In the graph, the Y-axis represents the average number of circuits (including fractions, which are generally unavailable) that must be sold of the capacity shown on the X-axis for a CLEC to attain revenue needed to offset the deployment costs.

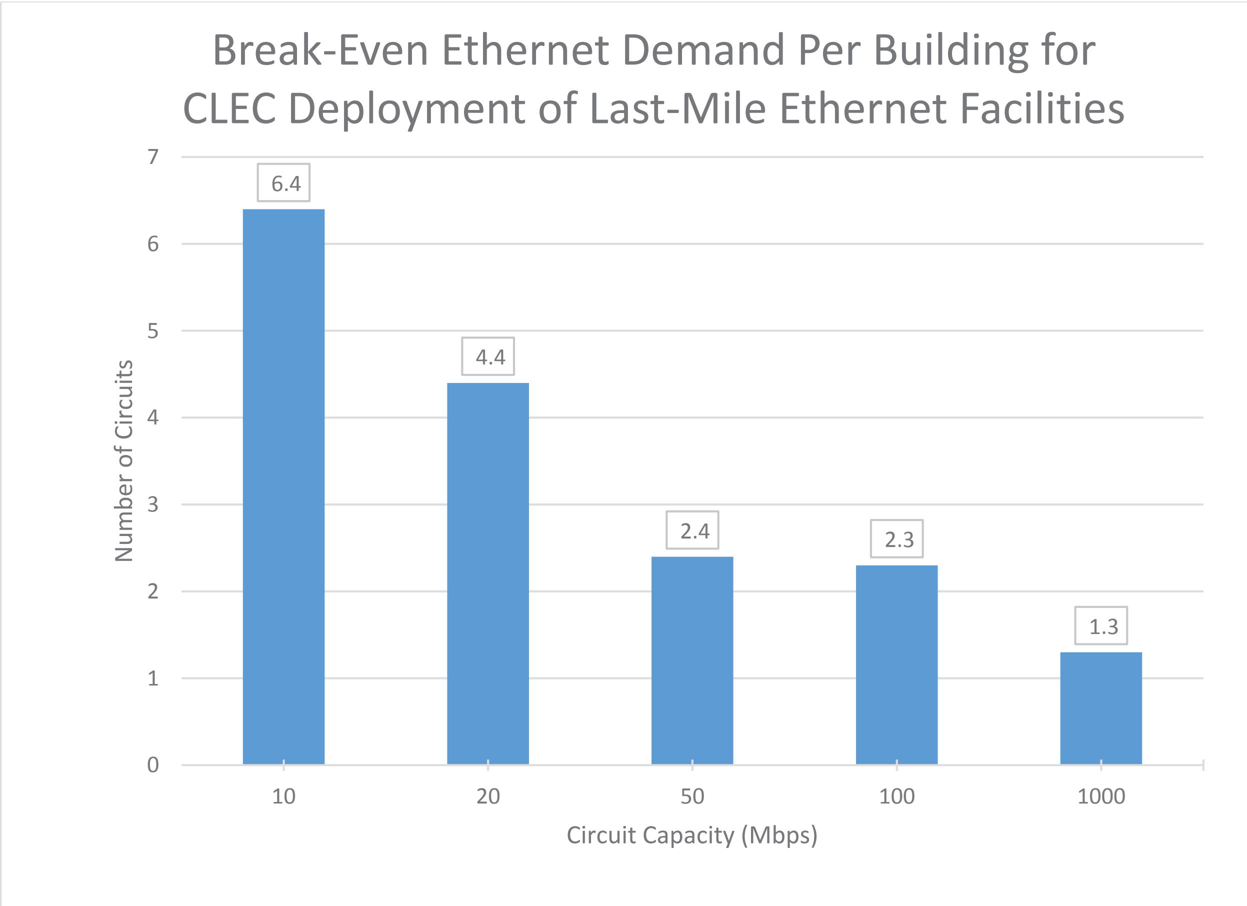
---

18 Like the CAM, this calculation accounts for an 8.5% cost of capital.

19 There is minimal availability of pricing data for retail Ethernet services. Retail Dedicated Internet Access (DIA) Ethernet prices reported by Telogical, an industry recognized source, represent a limited sample covering 22 cities. The survey contains a mix of providers, capacities purchased, quality of service, and contract terms. For each capacity purchased, the average of all survey responses was used. Based upon the source documents, CPE and transport charges were removed when specified (granular retail rate element details were not available in all instances). An alternate source, Telarus, Inc., shows an average price of $2,500 per month for 1 Gbps, dating to November 2013. No detail is shown regarding QOS or contract term, and 1 Gbps is the only rate quoted. *See Gigabit Ethernet Service Providers*, TELARUS, http://www.telarus.com/service-providers/gigabit-ethernet.html (last visited June 3, 2015).

20 This value was shown in Table 2. In the cases where a single building contains multiple active end user customers, the electronics at the building are capable of being multiplexed to accommodate multiple customers in the same building at different Ethernet capacity levels. A CLEC would move from 1 Gbps to 10 Gbps electronics only if total customer demand warranted provisioning of the additional capacity.

Figure 2—**Number of Ethernet circuits that must be purchased in a building for a CLEC to break even**



The monthly building space and power rate is a significant portion of the total cost driving this analysis. As noted previously, the building rental fee from the AT&T study (which is consistent with Windstream's present-day experience) was retained for this analysis, and assumed to be $678 per month. If the presumed building rental fee did not apply, a single 1 Gbps circuit could be economically deployed to each building, with the number of lower capacity connections necessary to achieve the revenue hurdle also reduced.[21]

As discussed below in the "Sensitivity to Density and Market Share" section, the business density in the target market as well as market share of an individual provider also have a significant impact on the cost analysis. If the CLEC adds more locations onto the ring, the average cost per served location drops, and thus the revenue hurdle drops.

---

21 Excluding the presumed building rental fee, the revenue hurdle would be $2,034 per month (=$2,712-678).

Build-Versus-Buy Analysis

In the build-versus-buy view, the analysis compares the per building monthly costs resulting from building the local network facilities (fiber ring, laterals, and electronics) described above to the costs of leasing wholesale Ethernet services from an ILEC (assuming no special construction charges).

The original AT&T study considered when a CLEC should lease last-mile access, rather than build its own facilities, when provisioning DS3 special access services, and found that it made economic sense for the CLEC to build out last-mile facilities only when at least 3 DS3 circuits, or 134 Mbps, was required in each building.[22] As noted previously, this AT&T analysis presumed a 30-mile ring with 20 connected buildings.

We replicated this analysis for Ethernet services to consider the extent to which a CLEC would prefer to lease last-mile access, versus overbuild the incumbent, and how decreasing wholesale prices would impact a CLEC decision to construct its own last-mile facilities. The wholesale Ethernet rates used for this analysis represent the average of published 36-month contract term switched Ethernet service rates for AT&T and CenturyLink.[23]

As shown in Figure 3, when average wholesale published rates are considered, it now appears, employing the study assumptions described earlier in the paper, to be preferable for a CLEC to lease wholesale Ethernet service than to build out new facilities to support capacity when less than 110 Mbps is required by the customer(s) in a building, as compared to the equivalent 3-DS3 (134 Mbps) break even in the AT&T study.[24]

Leasing, of course, becomes more attractive to a CLEC if the ILEC offers a discount for volume purchases. To illustrate the impact of a large volume discount, we include an alternate scenario in Figure 3 where it is assumed that a CLEC is able to negotiate a substantial discount of 50% off the published wholesale rates. The 50% assumed discount is used for illustrative purposes to demonstrate the impact of a significant leasing discount, but actual discounts could vary. The alternative break-even point is reflected by the second (blue) line in Figure 3.

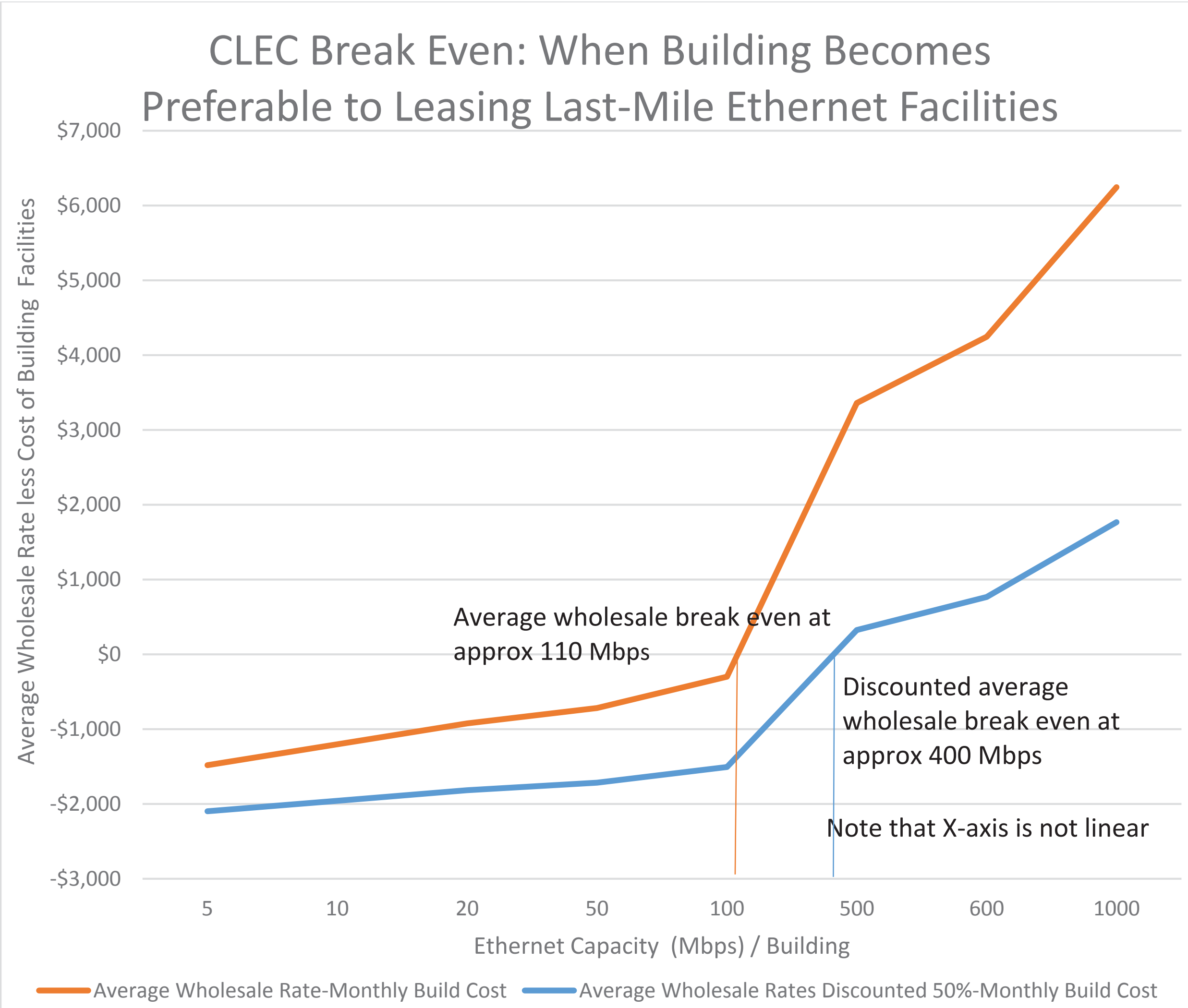
---

22 The AT&T study, however, did not perform a revenue hurdle analysis.

23 Sources: AT&T Switched Ethernet Guidebook (12/15/14), Port, Bandwidth & Network to Network Interface, Non-Critical class of service. Qwest Communications Rates and Services Schedule Interstate No. 1 (5/19/14) Metro Optical Ethernet (MOE) Port, Bandwidth Profile & CO MOE and CO Connecting Channel, 3 year term, Non-Critical class of service. AT&T and CenturyLink do not offer all the same Ethernet capacity tiers. As an example, AT&T does not show a 1 Mbps rate, while CenturyLink does. This analysis only considers wholesale rates for Ethernet products at capacity tiers offered by both AT&T and CenturyLink. For capacity above 1 Gbps only AT&T published a rate. We were unable to find public Verizon Ethernet rates at any capacity level.

24 To explore changes in construction costs, Section Two elaborates on the extent to which network deployment costs have changed over time.

Figure 3—**When building facilities becomes preferable to leasing**



As illustrated above, assuming a 50% ILEC discount off leased Ethernet rates expands the capacity tiers in which it is more cost effective for the CLEC to lease last-mile access than construct its own facilities, employing the study assumptions described above. With the 50% discount, this analysis suggests that it now would make more sense for the CLEC to lease wholesale Ethernet services than build out its own last-mile facilities when provisioning up to approximately 400 Mbps capacity to each building.

At initial viewing, a comparison of our modern-day analysis to AT&T's prior analysis might prompt the conclusion that CLEC wholesale leasing conditions for business services at higher capacity levels have remained relatively stable—or, with volume discounts, have significantly improved. However, a build-versus-buy analysis does not take into account retail marketplace conditions that will affect the ultimate viability of providing competitive service.

In particular, wholesale rates should be compared to retail rates in the marketplace when considering the economic viability of leasing facilities. To that end, Table 3 below compares the average retail rates observed by Telogical to the average AT&T/CenturyLink wholesale rates (with and without an assumed 50% volume discount):

Table 3—**Comparison of retail and wholesale rates**

Ethernet Bandwidth (Mbps)	Telogical Average Retail Pricing	AT&T and CenturyLink Average Wholesale Pricing	
		Public	With 50% Discount
10	$427	$1,510	$755
20	$616	$1,790	$895
50	$1,122	$1,994	$997
100	$1,196	$2,413	$1,206
1000	$2,157	$8,858	$4,479

This table suggests that leasing wholesale Ethernet access—even when it may be economically preferable to building—may not be a viable means for a CLEC to provide Ethernet service in some instances because retail Ethernet rates in the marketplace, based upon analysis of Telogical data, may be lower than the wholesale rates (even when a 50% discount is presumed) for many of the service speeds. In such cases, the CLEC would not offer Ethernet services, because it is infeasible for a CLEC to expect to recover its wholesale lease expense by charging retail rates far above what other carriers are charging in the marketplace. Additional data and analysis—reflecting rates experienced on both on the wholesale and retail "sides"—should be undertaken to elucidate this potential concern.

Moreover, comparing this build-versus-buy analysis with the revenue hurdle analysis shows that available wholesale Ethernet rates, even if at levels below retail rates, may not have a meaningful impact on a CLEC's decision to deploy its own-last mile facilities. The analyses suggest that an economically rational CLEC will base its decision to self-deploy on the revenue hurdle analysis, which, as noted above, establishes that self-deployment to serve a single customer with less than 1 Gbps of capacity per building (i.e., $2,712/month in revenue) would be uneconomic. In this situation, the fact that wholesale lease payments may present a more appealing option at certain speed tiers below 1 Gbps (e.g., at/below 400 Mbps when a 50% wholesale discount is presumed) would appear to be irrelevant to the CLEC's decision to build; the only way in which wholesale rates would impact the CLEC's decision making is if leasing appeared to be preferable at levels above 1 Gbps of capacity, i.e., at levels where self-deployment presents an economically viable alternative for the CLEC.[25] As modeled, the

[25] It should be noted that, under certain circumstances, the build-versus-buy analysis may be the tradeoff driving a CLEC's decision as to whether it should self-deploy its own last-mile facilities. For example, if the wholesale price were meaningfully lower than the retail market price for comparable service and the revenue hurdle was significantly lower, then the model suggests that an economically rational CLEC would be more likely to be primarily focused on the build-versus-buy analysis when determining whether it was economically efficient for the CLEC build its own last-mile network facilities.

availability of wholesale Ethernet alternatives, therefore, does not appear to crowd out economically efficient construction of CLEC fiber facilities in the last mile.

Sensitivity to Density and Market Share

The analysis thus far is based upon the baseline AT&T modeling assumptions of a network providing services to 20 revenue-generating locations over a 30-mile ring path. This section of the paper examines the sensitivity of unit cost to density and market share.

The market share for a carrier is the number of locations served by the carrier (active locations) divided by the total number of potential locations in the market that its network passes. For the purposes of this sensitivity analysis, the market share represents the total number of locations in the market, assumed to be 200 locations, multiplied by the business market share.

Non-residential market share values used in this analysis were based upon GeoResults data.[26] The study is summarized as follows:

Table 4—**Non-Residential market share values corresponding to GeoResults data**

Market Share	Percentage of Total Marketplace
Nationwide market share of the single most successful CLEC[27]	5.03%
Average single market share of the largest CLEC in each market	10.52%
Nationwide market share held by all CLECs	26.00%
Nationwide market share held by all incumbent LECs	58.00%

As market share increases along a particular fiber ring, the average cost of a served building falls, and thus the revenue hurdle level also falls.

While market share reflects a carrier's success in selling its services, the length of cable facilities required to pass the potential locations varies with the business density, expressed in the number of businesses per road mile.[28] As business density increases, fewer miles of cable are required to pass the

[26] In particular, non-residential market share values used in this analysis were based on estimated expenditures by non-residential customers on wireline communications during the second quarter of 2014, as compiled by the independent market research firm GeoResults. CLEC market shares include revenues from services both over CLECs' network facilities as well as last-mile facilities leased from incumbent LECs. The GeoResults data were analyzed by Windstream, which accessed the GeoResults Marketing Level Business and Telecom Database. GeoResults reviewed and approved the market share figures for FCC filing purposes.

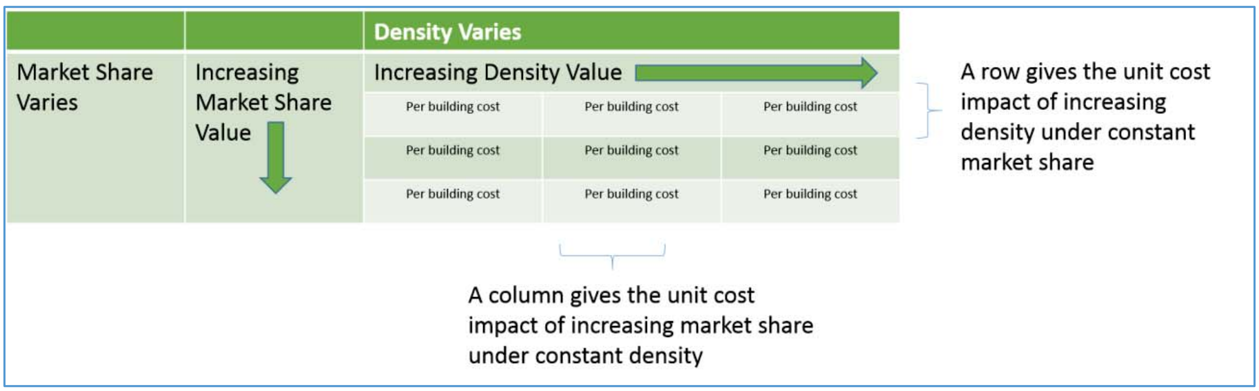
[27] The most successful CLEC represents the CLEC with the highest national non-residential market share according to GeoResults data.

[28] Customers have been assumed to be evenly distributed along the route to simplify the analysis. The mix of aerial, buried, and underground plant has been retained, although it is likely to change with density.

same number of locations; contrast a dense urban business district with several multi-tenant buildings per block to a suburban industrial park with one building per acre or a rural area where services are required by scattered farms, industries, and cell sites. Put differently, as business density increases, then at a given level of market share (i.e., held constant), the average cost of a served building falls, and thus the revenue hurdle level also falls.

Because market share and density both impact per-unit cost, their joint impact should be considered in the sensitivity analysis. It is possible to expand the analysis to show the impact of density as well as the impact of market share within the 200 business location market described earlier. The results can be shown in a table as demonstrated in Figure 4.

Figure 4—**Impact of density and market share**



Although the resulting table may appear complex in totality, it is simplified by considering only a single row or column at a time. Reading down a column indicates the impact on per-active-location cost when the density of a market is constant and market share changes. Reading across a row indicates the impact on per active location cost when the market share is constant but the density of the market is changing.

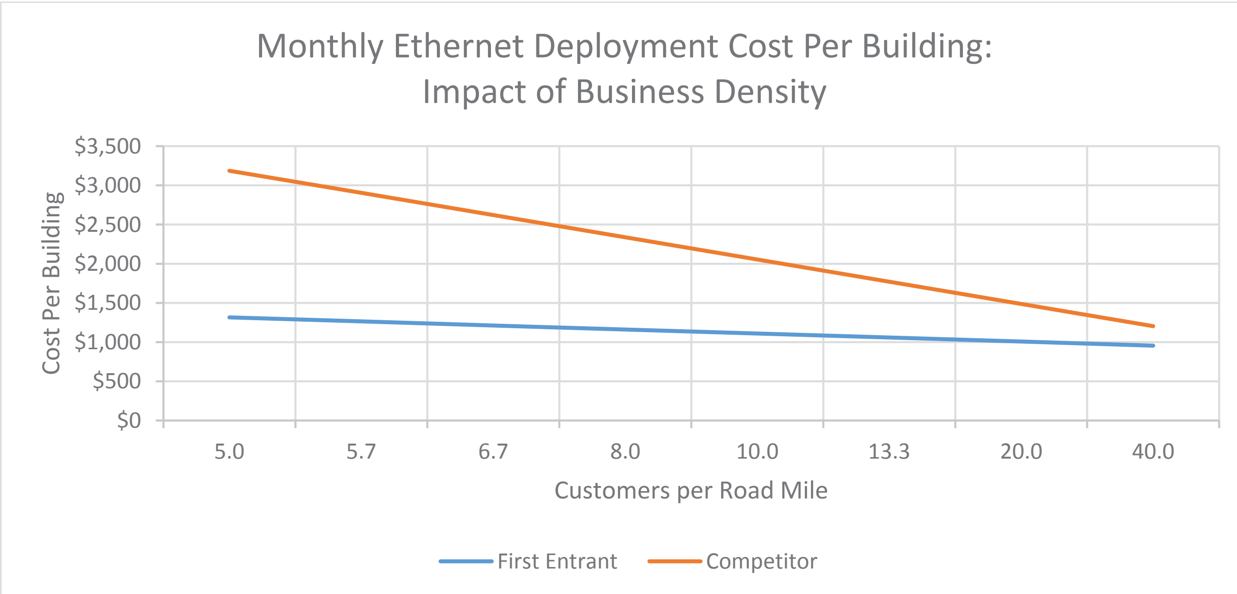
To elaborate on this approach to using the data, see Table 5 below. This table demonstrates the sensitivity of both market share and density to per active location cost. The baseline modeling assumption (20 active locations served with 1 Gbps Ethernet on a 30 mile ring) is shown by looking in the column labeled 6.67 (200 potential locations / 6.67 locations per mile = 30 miles) intersected with the row labeled 10% (20 active / 200 potential locations). The intersection of this row and column (highlighted in yellow) yields $2,712 per month, which is the value shown earlier in the paper (Table 2, Per Building: Ethernet, up to 1 Gbps), given 20 active locations. Rows with blue colored text correspond to the market share values identified by GeoResults data (Table 4, above).

Table 5—**Cost per customer location for a market of 200 locations, varying density and market share.**

	Density	**5.00 Bldgs/Mile**	**5.71 Bldgs/Mile**	**6.67 Bldgs/Mile**	**8.00 Bldgs/Mile**	**10.00 Bldgs/Mile**	**13.33 Bldgs/Mile**	**20.00 Bldgs/Mile**	**40.00 Bldgs/Mile**
	Ring Size	40 Mile	35 Miles	30 Miles	25 Miles	20 Miles	15 Miles	10 Miles	5 Miles
Market Share	**No. of Buildings**								
5.03%	10 Bldgs	$ 5,669	5,076	4,484	3,891	3,299	2,706	2,114	1,521
10.00%	20 Bldgs	3,308	3,010	2,712	2,414	2,116	1,818	1,520	1,222
10.52%	21 Bldgs	3,187	2,904	2,621	2,338	2,054	1,771	1,488	1,204
15.00%	30 Bldgs	2,495	2,297	2,098	1,899	1,701	1,502	1,303	1,105
20.00%	40 Bldgs	2,101	1,952	1,803	1,654	1,505	1,356	1,207	1,058
26.00%	52 Bldgs	1,826	1,711	1,597	1,482	1,368	1,253	1,138	1,024
30.00%	60 Bldgs	1,699	1,599	1,500	1,401	1,301	1,202	1,103	1,003
35.00%	70 Bldgs	1,587	1,502	1,417	1,332	1,246	1,161	1,076	991
40.00%	80 Bldgs	1,498	1,423	1,349	1,274	1,200	1,125	1,051	976
45.00%	90 Bldgs	1,433	1,367	1,301	1,235	1,168	1,102	1,036	970
50.00%	100 Bldgs	1,382	1,322	1,263	1,203	1,143	1,084	1,024	965
58.00%	116 Bldgs	1,315	1,264	1,212	1,161	1,110	1,058	1,007	956
65.00%	130 Bldgs	1,271	1,225	1,179	1,133	1,088	1,042	996	950
70.00%	140 Bldgs	1,242	1,200	1,157	1,115	1,072	1,029	987	944
75.00%	150 Bldgs	1,221	1,181	1,141	1,102	1,062	1,022	982	943
80.00%	160 Bldgs	1,199	1,162	1,124	1,087	1,050	1,013	975	938
85.00%	170 Bldgs	1,182	1,147	1,112	1,077	1,042	1,007	972	937

Figure 5, below, compares two unit cost curves to illustrate the cost advantage gained by larger market share. Offering a conservative view of the differential experienced by CLECs, the "Competitor" line (orange) demonstrates the impact on unit cost of changing density given a constant market share of 10.52%, the average non-residential market share of the largest CLEC based upon GeoResults data.[29] For comparison, the "First Entrant" line (blue) in Figure 6 shows the unit costs based on the average market share held by the incumbent LECs (58%).

Figure 5—**Cost per building under changing density given constant market share**

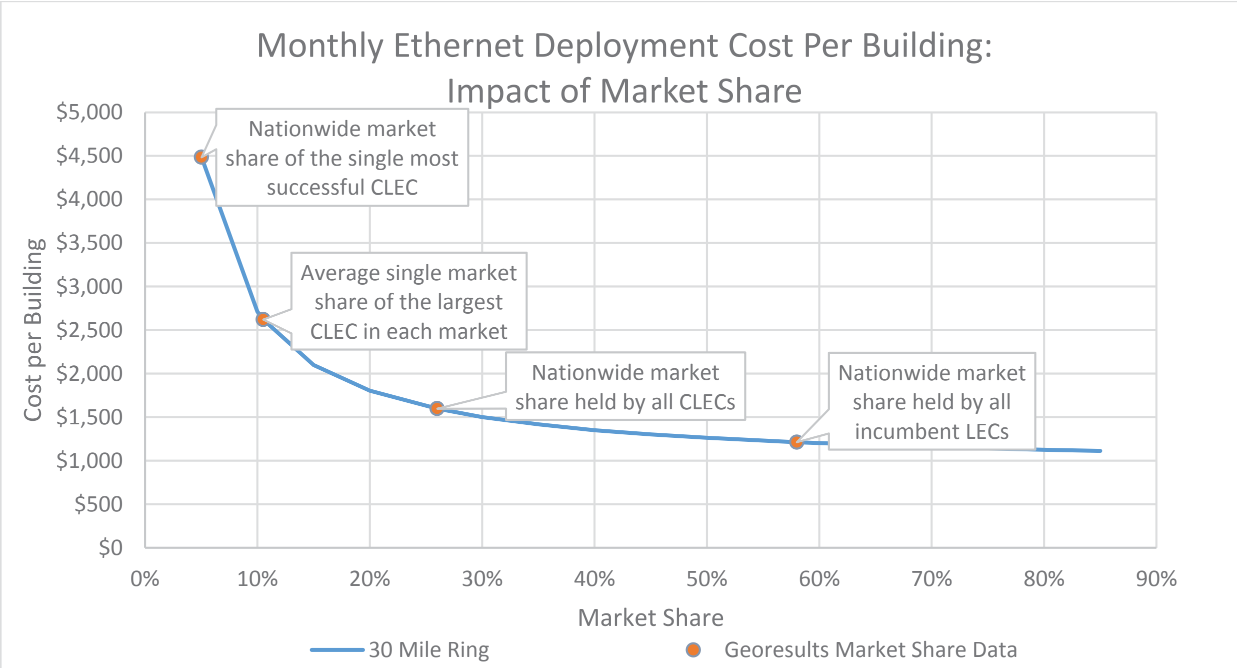


Further elaborating on this distinction, Figure 6 selects a single Density/Locations per Road Mile column to isolate the effect of market share. In particular, the example uses a 30-mile ring and further demonstrates a substantial decrease in unit cost as market share increases.

---

29 Even if all CLECs in a market consolidated into one or otherwise shared the same infrastructure, Table 5 shows the ILEC still would possess a significant per-location cost advantage, on average, over the CLECs across all density levels, as the market share of the former (58%) still would dwarf that of the latter (26%).

Figure 6—**Cost per customer location under changing market share given constant density**



In conclusion, Table 4 and Figures 5 and 6 provide a clear picture that the per-building active location cost decreases as market share and density increase, as well as the combinative impact of changing market share and density.

Attachment B

NETWORK COST DIFFERENTIALS OVER TIME

White Paper #2

This CostQuest white paper considers communications network cost differentials between the early 2000s and the present day. This assessment uses publicly available information where possible and actual cost information from Windstream when not. We reviewed capital related to labor and placing, capital associated with electronics and fiber-optic cable, and the costs to operate and maintain the network and related services. These data suggest that—when accounting for productivity improvements, price changes, and capacity improvements in electronics—costs for building, operating, and maintaining fiber/IP services generally are less than those for copper/TDM services of comparable capacity. The lower deployment costs for fiber/IP services are taken into account in the prior analysis, which considers the modern-day costs for a CLEC to build out its own last-mile facilities.

First, the cost of labor and placing over time was reviewed. Bureau of Labor Statistics data show the cost of labor per hour has increased by approximately 22% (in total) since 2002, the year when AT&T produced its prior network costs analysis.[1] But these data do not provide insight into how much of this general wage change is offset by productivity improvements achieved with new efficiencies in network construction practice. Known changes in fiber placement that have improved cost efficiency are: (1) movement from manual splicing of individual fiber strands to the use of ribbon cable and fusion splicers; (2) use of connectorized drops; (3) reduction in the depth for buried drops; and (4) introduction of micro-trenching.

Second, changes in fiber material costs demonstrate clear cost reductions over those in the early 2000s. The price of fiber-optic cable has decreased approximately 19% since 2002.[2]

The drop in fiber prices and the assumed productivity improvements is supported by a CSMG analysis concluding that the cost to pass a location with fiber has dropped over time, as shown in the figure below:[3]

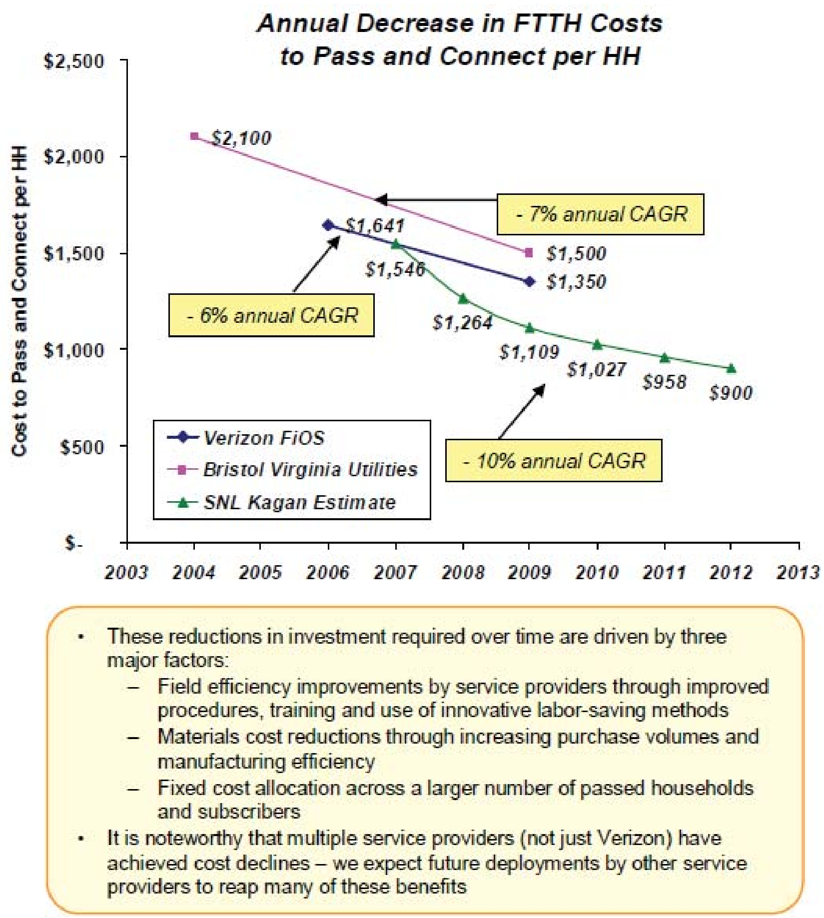
---

1 *See Occupational Employment Statistics*, Bureau of Labor Statistics, U.S. Dep't of Labor (updated March 25, 2015), data for OCC CODEs 49-2021, 49-2022, and 49-9052, (compare "A MEAN values" for May 2014, available at: http://www.bls.gov/oes/special.requests/oesm14nat.zip, file "national_M2014_dl.xlsx" with "A-MEAN" values for 2002, available at: http://www.bls.gov/oes/special.requests/oes02nat.zip, file "national_2002_dl.xls"). 2002-2014 trends were measured for each OCC Code, and then averaged across all three OCC codes.

2 *See Series Report,* Bureau of Labor Statistics, U.S. Dep't of Labor, Produced Price Index Industry Data, Series ID "PCU3359213359210", available at: http://data.bls.gov/cgi-bin/srgate (compare December 2003 (value=100) with December 2014 (value=80.6)).

3 Letter from Thomas J. Navin, Wiley Rein, to Marlene H. Dortch, Secretary, FCC, at 17, GN Docket No. 09-51 (filed Oct. 15, 2009).

Figure 1–**FTTH cost trends**



Source: FCC Filings, SNL Kagan, CSMG Analysis

The CSMG analysis referenced above considers costs to build out a Fiber To The Home ("FTTH") network (i.e., a mass market deployment). While FTTH cost does include the splitter cost (unique to a residential scenario), the majority of the cost is comprised of fiber, placement, and structure costs, i.e., costs pertaining to deployments to business service customer locations as well. The circumstance of providing a fiber connection to a business may vary from the broad averages described by CSMG, but two of the three cited drivers for decline in FTTH costs are also relevant to deployments to business locations: field effeciency improvements and material cost reduction.

Third, the cost of electronics to provide comparable service has decreased significantly, as the table below shows:

Table 1—**Cost changes in electronics**

Comparison	Serving 1-7 DS1	Serving 28 DS1	Serving 3 DS3
2002[4]	$ 77,088	$ 80,088	$ 139,614
2014[5]	$ [redacted]	$ [redacted]	$ [redacted][6]

The change in electronics costs is due to a variety of factors, such as increased processing capabilities and improved economies in producing equipment over time. Also important are new technologies that allow more flexible deployment configurations for a given service, including the following innovations:

- End-to-end multiplexer pairs are no longer needed. Multi-function "platforms" aggregate customers onto the same Network Element (NE) that supports the transport ring or rings.
- Digital cross connects are practically obsolete; few vendors still manufacture them. The multi-function NEs perform grooming internally. At most, a smaller NE may be necessary to groom DS1s onto DS3s or sub-1G Ethernet onto 1GE, which are then transferred to the larger NE for transport. A carrier may accept the low transport fill to avoid the extra element.
- Prices for equipment still used today have dropped. The $20,000 OC3 multiplexer of 2002 can be replaced by an approximately $13,000 OC12 multi-function Network Element, which is upgradable to Ethernet as the customer's needs change. This represents a 35% price decline with a 4x capacity increase.
- Conversion to Ethernet provides even greater economies. Ethernet customer premise equipment (1 Gbps) is approximately $2,800, a 79% cost reduction with a 60% increase in capacity possible as compared to an OC12.

---

4 *See* AT&T Study Letter, Attach. B.

5 Based upon confidential pricing data supplied by Windstream.

6 LSO and customer end equipment, including installation. The recommended Windstream customer end configuration has the capacity to serve 28 DS1 and 8 DS3 for $18,780. The table's values represent equipment to provide either DS1 or DS3 service.